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ANALYSES OF IRRIGATED SOILS FROM
THE POPLAR RIVER BASIN

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Prepared by: Abe Horpestad, Ph.D
Limnologist
Water Quality Bureau
Environmental Sciences Division
Montana Department of Health
and Environmental Sciences

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ABSTRACT

Generally, low sodium adsorption ratios and electrical conductivities from soils throughout the basin indicate that present irrigation techniques are generally adequate to prevent salinization of soils. However, the positive correlation between years of irrigation and these factors indicate that salinization will occur in the future unless irrigation practices are modified.

There is no simple relationship between years of irrigation and boron content of these soils. However, there is a positive correlation between soil boron content and the mean boron concentration of the adjacent streams. Soil boron concentrations are not as high as one would expect from the high boron concentrations in the streams.

ANALYSES OF IRRIGATED SOILS FROM THE POPLAR RIVER BASIN

INTRODUCTION

Twenty-four soil samples from the Poplar River Basin were analyzed. Thirteen samples from the upper basin were collected by Soil Conservation Service personnel and analyzed by the Montana State Water Quality Bureau Laboratory. Each of these thirteen samples were collected from a different site. Surface samples were collected with a tile spade, while the deeper samples were collected with a pressurized hydraulic probe or a hand auger. Soil from each horizon was individually packaged in plastic containers, returned to the field office, air dried, and repackaged in plastic. They were then shipped to the Montana State Water Quality Bureau Lab in Helena. In the lab, equal volumes from each horizon at a site were composited and analyzed using procedures recommended in the United States Department of Agriculture Handbook #60 (1969). Boron analyses were performed for total boron. These analyses included spikes and duplicate samples (1 in 5) for quality control.

Eleven samples from the lower basin on the reservation were collected by Morrison-Maierle personnel. These samples were collected, one per site, using a three inch Perrien closed-bucket auger. These samples were also held and shipped in plastic containers after air drying. These samples were analyzed by the Soils Laboratory at Montana State University using methods recommended in the United States Department of Agriculture Handbook #60 (1969). However, these boron analyses were for the hot water soluble fraction. These analyses relied on frequent analyses of standards for quality control. Because of the better state of soil knowledge in the upper basin, that is, above the reservation in Daniels County, collection of these samples included the determination of the soils series (Appendix 1). These samples also included a listing of the years of irrigation. This information was not available for the sites on the reservation. In addition, most of the soils samples from the reservation did not contain sufficient volume for a boron analysis.

Approximate sample locations are shown in Figure 1 and detailed in Appendices 1 and 2. Analytical results are listed in Tables 1 and 2 for the upper basin. Results from the lower basin are summarized in Tables 3 and 4, while complete analytical results are in Appendix 3.

RESULTS AND DISCUSSION

The United States Department of Agriculture Handbook #60 classifies soils in three (by inference four) classes. In saline soils, "the conductivity of the saturation extract is more than 4 mmhos/cm at 25^{o}C and the exchangeable sodium percentage is less than 15". In saline-alkali soils, "the conductivity of the saturation extract is greater than 4 mmhos/cm at 25^{o}C and the exchangeable sodium percentage is greater than 15". In nonsaline-alkali soils, the "exchangeable sodium percentage is greater than 15 and the conductivity of the saturation extract is less than 4 mmhos/cm at 25^{o}C". Thus, by inference, non-saline, non-alkaline soils would have an exchangeable sodium percentage less than 15 and the saturation extract conductivity would be less than 4 mmhos/cm at 25^{o}C. Although the exchangeable sodium percentage of these samples was not determined, the sodium absorption ratio (SAR) of the saturation extract was, and below values of 30, these values are essentially the same (USDA Handbook #60).

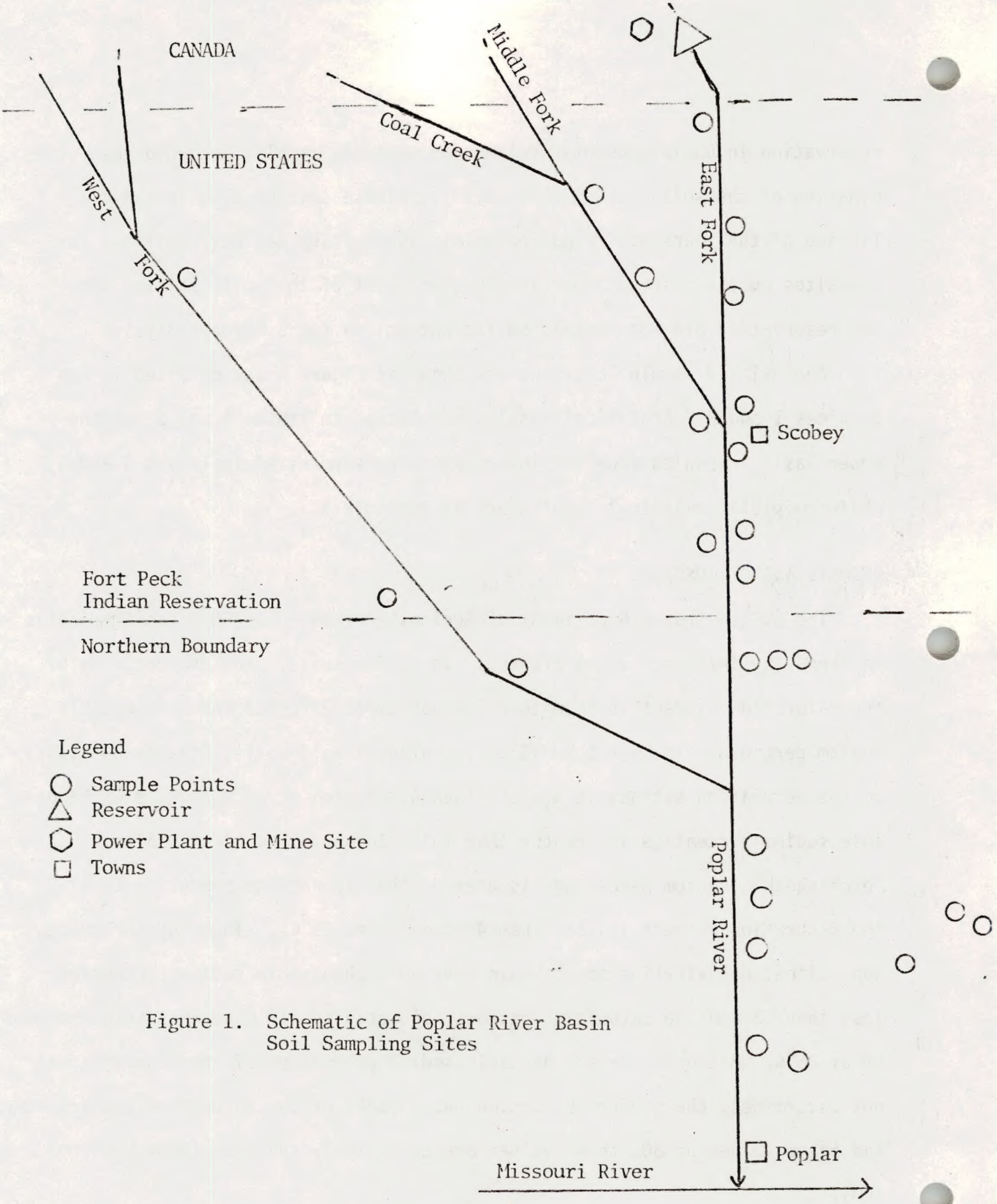


Figure 1. Schematic of Poplar River Basin Soil Sampling Sites

Table 1. Soil Sampling Locations in the Upper Basin and General Information

Field No.	Lab. No.	Sub Basin	Location	Length of Irrigation in yrs.*	Soil Series
99	44S	Middle Fork	T37N R46E Sec. 16	10	Havrelon Loam
100	45S	Middle Fork	T37N R47E Sec. 32	8	Havrelon Loam
101	46S	East Fork	T37N R48E Sec. 5	0	Trembles Fine Sandy Loam
102	47S	East Fork	T36N R48E Sec. 11	9	Cherry Silt Loam
103	48S	East Fork	T36N R48E Sec. 27	0**	Farnuf Loam
104	49S	West Fork	T33N R47E Sec. 33	25	Williams Loam
105	50S	Main Stem	T34N R48E Sec. 21	25	Havrelon Loam
106	51S	Main Stem	T34N R48E Sec. 26	14	Farland Silt Loam
107	52S	West Fork	T36N R43E Sec. 26	7	Farland Silt Loam
108	53S	West Fork	T34N R45E Sec. 36	1	Turner Loam
109	54S	Main Stem	T35N R48E Sec. 7	66	Havrelon Loam
118	55S	Middle Fork	T36N R48E Sec. 32	4	Havrelon Loam
119	56S	East Fork	T36N R48E Sec. 33	9	Lohler Loam

* Most figures are approximate

** Sub-irrigated hay field

Table 2. Analytical Results for Soil Samples from the Upper Basin

		all values are mg/l; cond.-umhos						
Field No.	Lab. No.	Boron (Total)	Ca (Saturation Extract)	Mg (Saturation Extract)	Na (Saturation Extract)	pH (Saturation Extract)	Cond. (Saturation Extract)	Sodium Adsorption Ratio (SAR)
99	44S	13.	18.	15.	150	8.2	1780	6.2
100	45S	10.	35.	17.	41.	8.3	1250	1.4
101	46S	19.	52.	8.4	160	8.1	2260	5.5
102	47S	12.	65.	11.	15.	7.5	1340	.45
103	48S	10.	120.	26.	92.	7.6	2990	2.0
104	49S	10.	26.	14.	86.	8.4	1770	3.4
105	50S	8.8	22.	8.4	66.	7.7	1030	3.0
106	51S	9.2	20.	13.	77.	7.6	1140	3.3
107	52S	7.5	25.	12.	6.5	7.6	760	.27
108	53S	7.0	31.	6.9	17.	7.6	700	.72
109	54S	18.	76.	76.	900.	8.4	7820	17.5
118	55S	13.	21.	14.	91.	8.3	1430	3.8
119	56S	12.	82.	40.	440.	8.3	6210	10.0

Table 3. Soil Sampling Locations in the Lower Basin and General Information

Site #1	Sub Basin	Location	Length of Irrigation in years*	Soil Series*
FP-1	Main Stem	T29N R51E Sec. 16AA	Yes	?
FP-2	Main Stem	T29N R51E Sec. 29ACC	Yes?	?
FP-3	Main Stem	T30N R51E Sec. 33DC	No	?
FP-4	Muddy Creek	T29N R53E Sec. 14A	No	?
FP-5	Muddy Creek	T29N R53E Sec. 8DDD	No	?
FP-6	Muddy Creek?	T29N R52E Sec. 34AAA	No?	?
FP-7	Main Stem	T28N R51E Sec. 24CCC	No?	Dooley?
FP-8	Main Stem	T28N R51E Sec. 16CCC	No?	Williams?
FP-9	West Fork	T33N R48E Sec. 24CB	Yes	Havrelon?
FP-10	West Fork	T33N R48E Sec. 24CA	Yes	?
FP-11	West Fork	T33N R48E Sec. 24DB	No	?

*Complete information was not gathered

Table 4. Analytical Results for Soil Samples from the Lower Basin*

Site #	All values mg/l; Cond. - ümhos						Sodium Adsorption Ratio (SAR)
	Boron "Hot Water Soluble"	Ca (Saturation Extract)	Mg (Saturation Extract)	Na (Saturation Extract)	pH (Saturation Extract)	Cond (Saturation Extract)	
FP-1	3.1	37	40	110		900	3.0
FP-2	4.1	94	66	434		3380	8.3
FP-3	3.3	166	178	761		600	9.7
FP-4	ND	33	33	127		1100	3.7
FP-5	ND	75	36	7		500	0.2
FP-6	ND	63	140	264		1470	4.2
FP-7	ND	53	31	126		500	3.4
FP-8	ND	57	180	279		2570	4.1
FP-9	ND	75	32	31		670	0.7
FP-10	3.78	76	57	109		1580	0.4
FP-11	3.13	63	46	32		1050	0.7

*Mean Values for all sampled horizons. See appendix for individual horizon values.

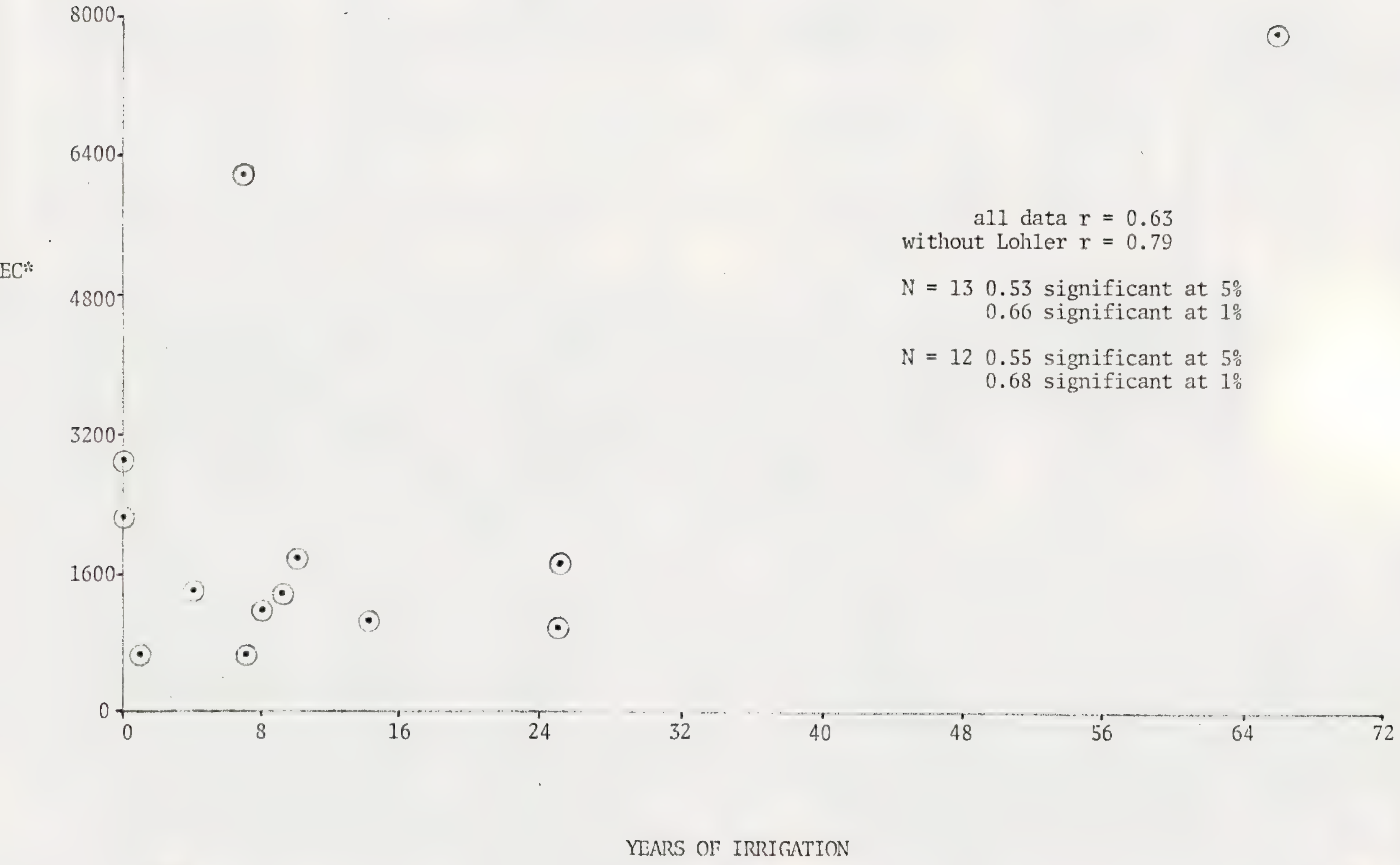
A consideration of the electrical conductances and sodium adsorption ratios of the samples indicate that sample #103 in the upper basin and #2 in the lower basin are slightly saline. Sample #103 is sub-irrigated and sample #2 may have been irrigated in the past. Sample #109 in the upper basin is saline-alkali and has been irrigated since 1911. Sample #119 in the upper basin is saline. This soil was only irrigated for nine years (from 1955 to 1965); however, this soil (Lohler) is usually saline (Smetana, 1978 personal communication).

There is a significant (5% level) correlation between years of irrigation and electrical conductance and between years of irrigation and sodium absorption ratio (1% level) in the upper basin. If the soil that is sub-irrigated is not treated as 0 years of irrigation, that is, dropped, the correlation with electrical conductance is significant at the 1% level (Figures 2 and 3).

Because of the variety of soil series present and the limited number of samples, it is not possible to make any inferences about the response of a soil type to irrigation. Likewise, because of the limited sample numbers and the diversity of irrigation techniques, inferences about possible relationships between these factors cannot be made. Actually, until about 1960, flood irrigation either by pumping or diversion was most common. Since that time, sprinkler irrigation has become more common. However, it is still not possible to accurately determine the amounts of waters which are, and have been, applied to leaching.

The preponderance of low electrical conductances and sodium adsorption ratios, even on soils which have been irrigated for up to 25 years, indicate that present irrigation techniques are generally adequate. But, the data does

Figure 2. Electrical Conductance versus Years of Irrigation
Upper Poplar River Basin, Montana



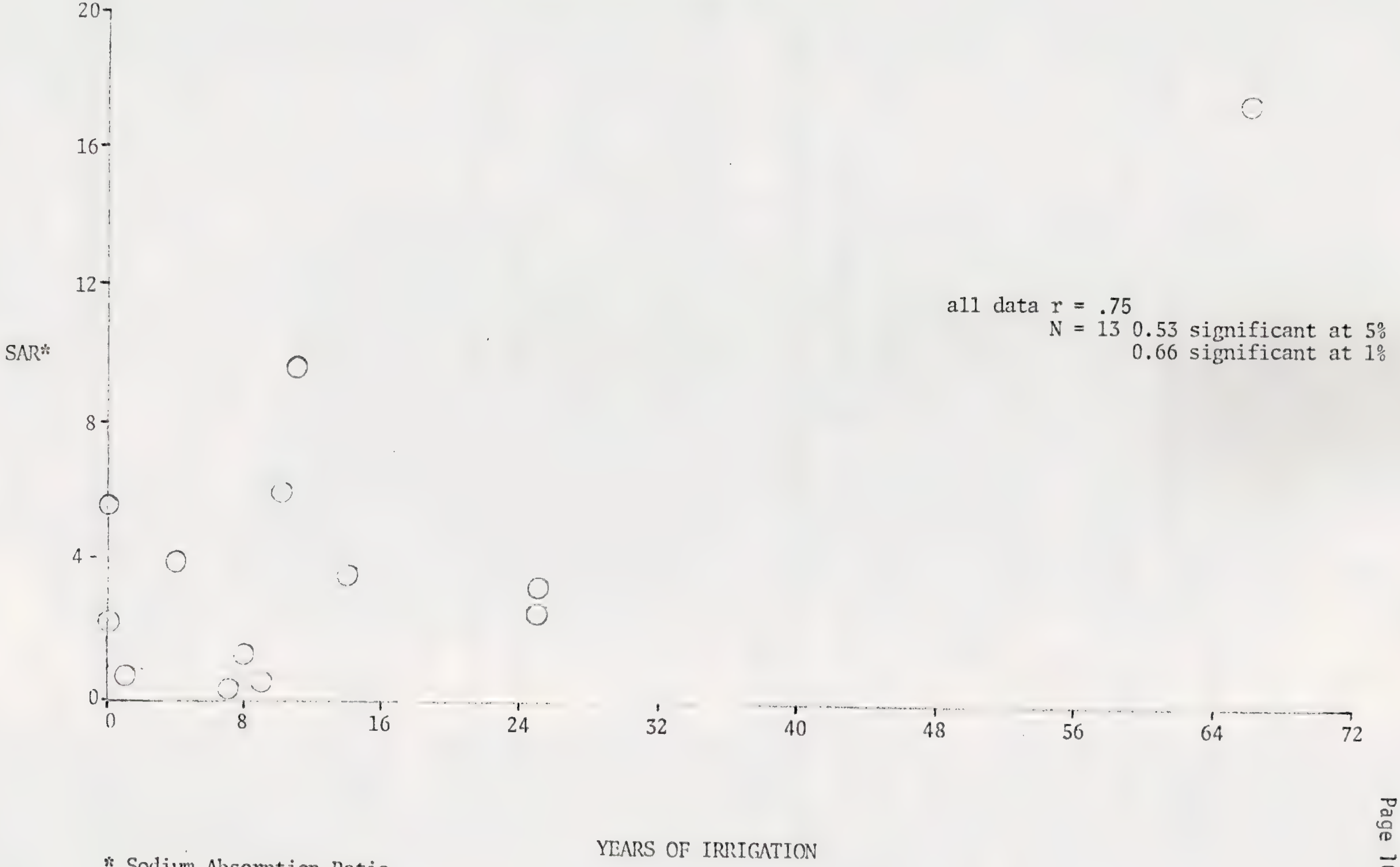
all data r = 0.63
without Lohler r = 0.79

N = 13 0.53 significant at 5%
0.66 significant at 1%

N = 12 0.55 significant at 5%
0.68 significant at 1%

* Electrical Conductivity in umhos

Figure 3. Sodium Adsorption Ratio versus Years of Irrigation. Upper Poplar River Basin, Montana



* Sodium Absorption Ratio

suggest that the increased salinity of irrigation water and increased use of such water could and probably would increase the soil concentrations. Such increases in soil salinity could have impacts on crop yields. However, by increasing the leaching fraction, these impacts could probably be avoided for some time.

There is no direct relationship between years of irrigation and boron concentration in the soils (Figure 4). There is a significant correlation (5% level) between the stream boron concentration adjacent to the sampling point and the boron concentration in the soil (Figure 5). These instream boron concentrations are average values from Montana Department of Health and Environmental Sciences Water Quality Bureau data and the United States Geological Survey data.

The correlation between instream and soil boron concentrations together with the high levels in Fife Lake in Canada (unpublished data indicate values over 5 mg/l are common) indicate that the soil boron is probably derived from stream water boron. However, the second highest boron concentration is in the soil which has been irrigated the longest and which should have a considerably lower concentration based on adjacent stream water boron concentration. Thus, there is apparently a complex relationship between boron concentration in soil and boron concentration in stream water, years of irrigation, and probably soil series and other factors.

Boron values discussed above are the total concentration in the soils, while the boron values for the lower basin are the hot water soluble concentrations. The relationship between these two parameters is not well understood. However, samples #10 and #11 from the lower basin are only 6 miles below samples #105 and #106 in the upper basin. Because the boron concentration in

Figure 4. Soil Boron Concentration versus Years of Irrigation.
Upper Poplar River Basin, Montana

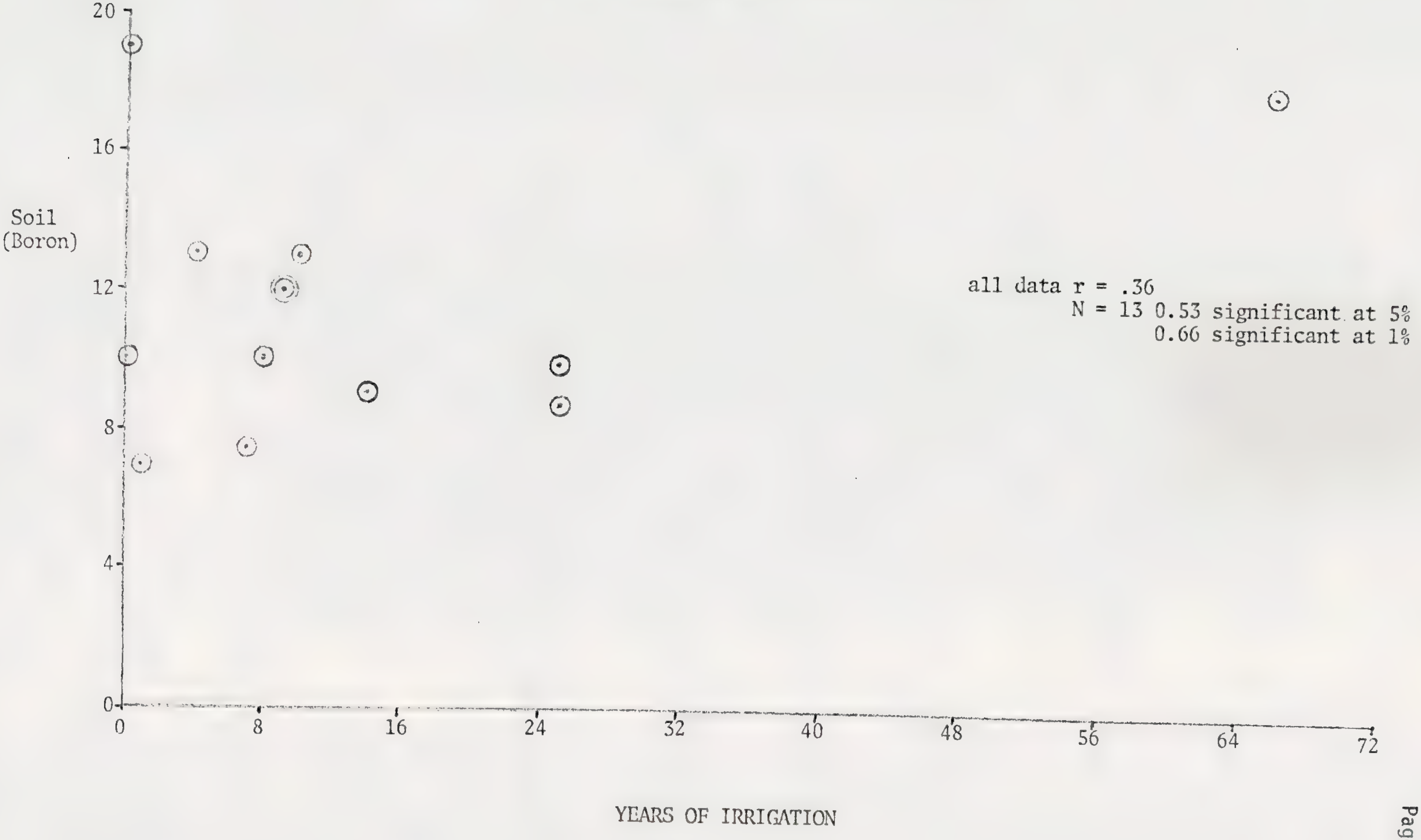
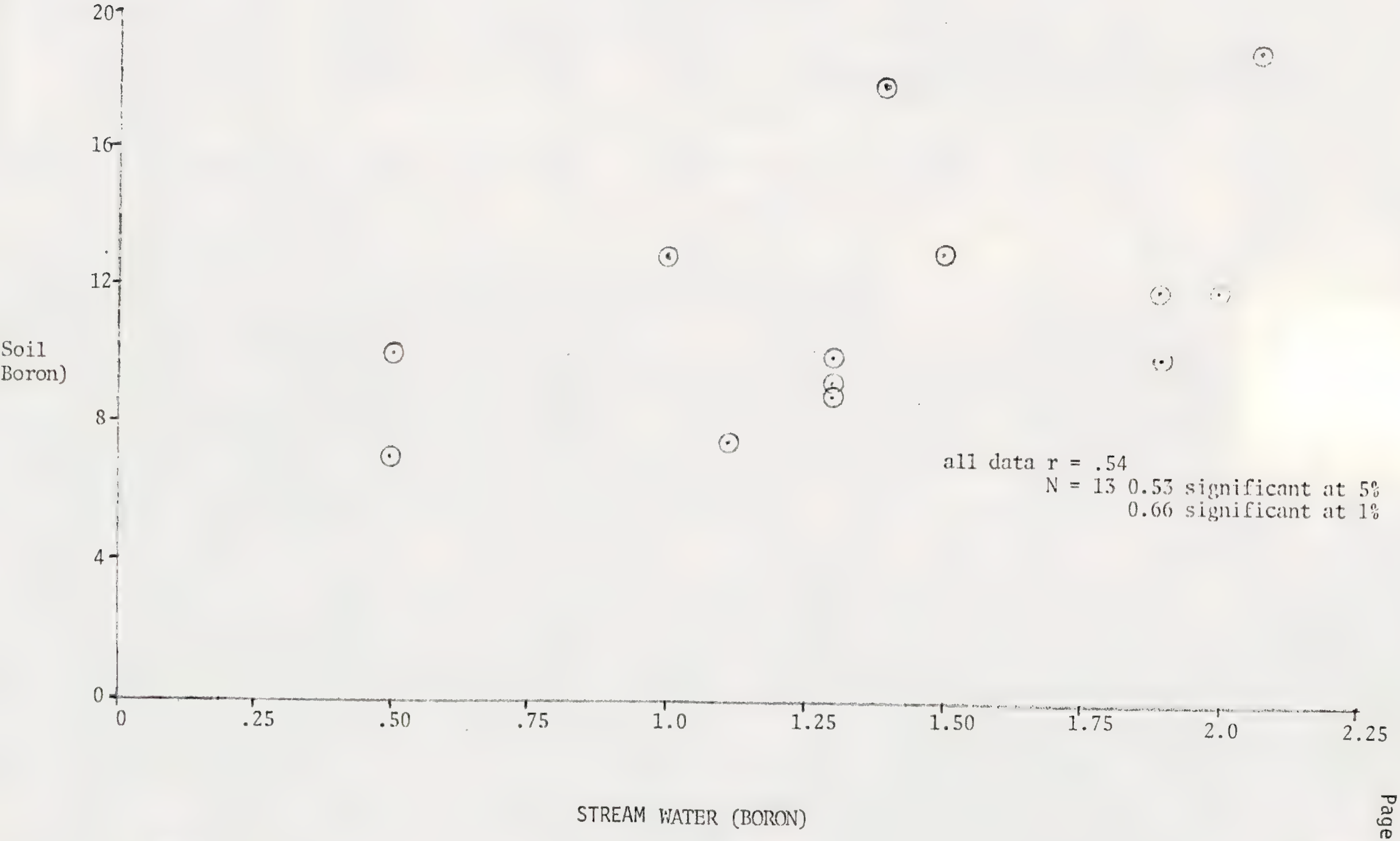


Figure 5. Soil Boron Concentration versus Adjacent Stream Boron Concentration. Upper Poplar River Basin, Montana



the soils of the upper basin are correlated to the stream water boron concentration, it is likely that the total boron concentration at stations #105 and #106 are comparable to the hot water soluble boron concentrations at stations 10 and 11 as the stream water boron concentrations should be essentially the same at these two points. Thus, a mean total concentration of 9 mg/l corresponds to a hot water soluble concentration of 3.2 mg/l. If this assumption is correct, and if the further assumption that the relationship can be extended to higher concentrations is also true, then the maximum hot water soluble boron concentration in the basin would be about 6 mg/l.

The Montana Department of State Lands requires saturation extract boron concentrations of less than 8 mg/l on reclaimed spoils. This value is based on an in-house literature review. The saturation extract boron concentration is lower than the hot water soluble boron concentration. The United States Department of Agriculture Handbook #60 (1969) states, "limits for boron in the saturation extract of soils can, at present, be given only on a tentative basis". However, other references state that for irrigation water, "the maximum concentration safe for even the least sensitive plants is 4 mg/l" and "that when boron in the irrigation water is .5 mg/l, its concentration in the soil solution may be more than 4 mg/l" McKee & Wolf, 1963. This concentration results from evaporation and transpiration of soil water. However, the absorptive capacity of the soil tends to limit the amount of boron in the soil solution until the absorptive capacity is exhausted. Water Quality Criteria 1972 recommends a maximum concentration of 2 mg/l in irrigation water.

The total soil boron concentrations in the upper basin are apparently similar to those in the Powder River Basin (Tidball and Ebens, 1976, Connor et. al., 1976). The boron concentration in the Powder River is usually about 0.3 mg/l (United States Geological Survey, Water Quality Records) and in the Poplar River, it is usually greater than 1 mg/l (Water Quality Bureau file). Based on the observed correlation between stream water boron concentrations and soil boron concentrations, you would thus expect the concentration in the soils of the Poplar River Basin to be 3 times those in the Powder River Basin. This is not the case. This may be due to differences in sorptive capacity of the soils, as this capacity is unkown in both cases. Nevertheless, it is difficult to rationalize the high boron concentration in the Poplar streams with the apparently low values in the soil.

SUMMARY

Soil salinities in the Poplar River Basin are generally low, but there are indications of increased salinities caused by irrigation. Some increased salinities are high enough that they may affect crop yields. However, these increased salinities could be controlled by increased leaching if sufficient water is available.

Concentrations of total boron in the soils of the upper basin are correlated to stream water boron concentrations. There is a lack of comparative data for soil concentrations and inadequate information to quantify the effects of different soil boron concentrations on tolerant crops. The effects of boron concentrations on tolerant crops could probably be defined by a small greenhouse experiment utilizing tolerant crops and different boron concentrations.

References Cited

Connor, J. J., J. R. Keith, and B. M. Anderson. 1976. Trace-Metal Variation in Soils and Sagebrush in the Powder River Basin, Wyoming and Montana. Jour. Research U. S. Geol. Survey. Vol. 4, No. 1, p. 49-59.

McKee, J. E. and H. W. Wolf, eds. (1963), Water Quality Criteria, Second ed. (State Water Quality Control Board, Sacramento), 548 p.

Smetana, D. R. 1978. Soil Scientist, Soil Conservation Service, Wolf Point, Montana. Personal Communication.

Tidball, R. R. and R. J. Ebens. 1976. Regional Geochemical Baselines in Soils of the Powder River Basin, Montana-Wyoming. Twenty-Eighth Annual Field Conference. Wyoming Geological Association Guidebook.

United States Salinity Laboratory Staff. 1969. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60. U.S. Department of Agriculture.

Water Quality Criteria 1972. EPA-R3-73-033 March 1973.

APPENDIX 1. SAMPLE LOCATIONS AND FIELD NOTES FOR THE UPPER BASIN

no pHs were encoded

SOIL SERIES: HAVRELON 15:08 MAR

Sample #

SURVEY SAMPLE NO.: S78MT 37 99
LOCATION: DANIELS CO. T37N, R46E 2400' E & 900' N OF SW CORNER SECTION 16 PHOTO 663.A
CLASSIFICATION: TYPIC USTIFLUVENTS: FINE-LOAMY , MIXED (CALCAREOUS) , FRIGID

SITE NO.: [redacted] 99
COUNTY: [redacted]
ELEVATION: 0746 METERS
MONTH SAMPLED: AUGUST
SLOPE: 01%
CLASS: NEARLY LEVEL
KIND: PLANE
ASPECT:
AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
PRECIPITATION: CM.
CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102 CM
PERMEABILITY: MODERATELY SLOW
DRAINAGE CLASS: WELL DRAINED
PHYSIOGRAPHY: FLOODPLAINS
STONINESS: CLASS 0
VEGETATION: CROPS - DRYLAND
PARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
CALCAREOUS

No pH's were encoded

HORIZON PROFILE DESCRIPTION

A P

(color missing)

0 - 18 CM. (0 - 7 IN.)
GRAYISH BROWN (10YR 5/2) EXTERIOR ; LOAM ; GRAYISH BROWN (10YR 5/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; STRONG MEDIUM SUBANGULAR BLOCKY MOIST STRUCTURE ; LOOSE , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; FEW SOFT THREAD-LIKE MASSES OF LIME ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; CLEAR SMOOTH BOUNDARY .

C 1

18 - 97 CM. (7 - 38 IN.)
GRAYISH BROWN (10YR 5/2) EXTERIOR ; LOAM ; GRAYISH BROWN (10YR 5/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; MASSIVE MOIST ; SLIGHTLY HARD , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; FEW SOFT THREAD-LIKE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; CLEAR SMOOTH BOUNDARY .

C 2

97 - 152 CM. (38 - 60 IN.)
LIGHT BROWNISH GRAY (10YR 6/2) EXTERIOR ; LOAM ; LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED ; GRAYISH BROWN (2.5Y 5/2) EXTERIOR MOIST ;

DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE MOIST ; SLIGHTLY HARD , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; MANY FINE , TUBULAR PORES ; FEW SOFT THREAD-LIKE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH. 8.4 (THYMOL BLUE) .

REMARKS: ALFALFA, BY DRS, MJH, PART OF POPLAR RIVER STUDY, HAVE SOIL ANALYSIS DATA, AREA WAS LAND-LEVELED, LOCATION 200' W & 100' N FROM NE CORNER OF IRRIGATED FIELD

OIL SERIES: [redacted] TREMBLES ↙ Sample # 16:45 MAR 2

URVEY SAMPLE NO.: S78MT [redacted]101
OCATION: 1900' N & 2400' W OF SE CORNER SECTION 5 T37N, R48N
LASSIFICATION: TYPIC USTIFLUVENTS: COARSE-LOAMY , MIXED (CALCAREOUS) , FRIGID

ITE NO.: ~~78~~101 COUNTY: ELEVATION: 0738 METERS MONTH SAMPLED: AUGUST
LOPE: 01% CLASS: NEARLY LEVEL KIND: PLANE ASPECT:
R TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
OIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
ATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
RECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102 CM
RMEABILITY: MODERATE DRAINAGE CLASS: WELL DRAINED
YSIOGRAPHY: FLOODPLAINS
GETATION: CROPS - DRYLAND STONINESS: CLASS 0
RENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
CALCAREOUS

HORIZON PROFILE DESCRIPTION

A P 0 - 13 CM. (0 - 5 IN.)
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; ; GRAYISH BROWN (2.5Y 5/2) CRUSHED ; V DK GRAYISH BROWN (10YR 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (10YR 3/2) CRUSHED MOIST ; WEAK FINE & MEDIUM SUBANGULAR BLOCKY DRY STRUCTURE ; SOFT , VERY FRIABLE , NONSTICKY , SLIGHTLY PLASTIC ; MANY FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; COMMON FINE & MEDIUM TUBULAR PORES ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.0 (BROMTHYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

C 1 13 - 122 CM. (5 - 48 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SANDY LOAM ; LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; MASSIVE ; SLIGHTLY HARD , FRIABLE , NONSTICKY , NONPLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; COMMON FINE & MEDIUM TUBULAR PORES , MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; CLEAR SMOOTH BOUNDARY .

IC 2 122 - 152 CM. (48 - 60 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SANDY CLAY LOAM ;

LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; OLIVE BROWN (2.5Y 4/4) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MANY FINE & MEDIUM PROMINENT GRAY (5Y5/1) MOIST .MOTTLES ; MANY COARSE PROMINENT GRAY (5Y5/1) MOIST MOTTLES ; MASSIVE ; HARD , FRIABLE , STICKY , SLIGHTLY PLASTIC ; FEW ROOTS ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; VERY STRONGLY ALKALINE PH- 9.6 (THYMAL BLUE) .

REMARKS: DRYLAND.ALFALFA BY MH, DRS

```
SOIL SERIES:                                      HAVRELON      sample #                         15:08 MAR
                                                               ↙
SURVEY SAMPLE NO.:                                S78MT  . 37100
LOCATION:           DANIELS CO. T37N, R47E 110' E & 1300' N OF SW CORNER OF SECTION 32 PHOTO 659-A
CLASSIFICATION:     TYPIC   USTIFLUVENTS:  FINE-LOAMY   ,  MIXED (CALCAREOUS)   ,  FRIGID

SITE NO.: 78100     COUNTY: [redacted]            ELEVATION: 0734 METERS         MONTH SAMPLED: AUGUST
SLOPE:        01%   CLASS:     NEARLY LEVEL       KIND:          PLANE           ASPECT:
AIR TEMPERATURE     ANNUAL:      DEGREES F        SUMMER:     DEGREES F          WINTER:     DEGREES F
SOIL TEMPERATURE    ANNUAL:      DEGREES F        SUMMER:     DEGREES F          WINTER:     DEGREES F
WATER TABLE:        DEPTH:       CM.              MONTH:                         KIND:    NO WATER TABLE
PRECIPITATION:         CM.                        CONTROL SECTION LIMITS --      UPPER: 025 CM  LOWER: 102 C
PERMEABILITY:       MODERATE                      DRAINAGE CLASS:  WELL DRAINED
PHYSIOGRAPHY:       FLOODPLAINS                                                  STONINESS: CLASS 0
VEGETATION:         CROPS - DRYLAND
PARENT MATERIAL:    HIGHLY  WEATHERED   ALLUVIUM
                    MIXED LITHOLOGY


  HORIZON                                         PROFILE DESCRIPTION

 A    P               0 -  13 CM.  (  0 -   5 IN.)
                    GRAYISH BROWN   (2.5Y  5/2) EXTERIOR     ; LOAM     ; GRAYISH BROWN   (2.5Y  5/2)
                    CRUSHED  ;  V DK GRAYISH BROWN  (2.5Y  3/2) EXTERIOR    MOIST    ;
                    V DK GRAYISH BROWN  (2.5Y  3/2) CRUSHED MOIST    ; MODERATE    MEDIUM
                    SUBANGULAR BLOCKY   DRY STRUCTURE    ; SLIGHTLY HARD    , FRIABLE  ,
                    SLIGHTLY STICKY  ,  SLIGHTLY PLASTIC    ; MANY    FINE &  MEDIUM  ROOTS
                    THROUGHOUT HORIZON   ; MANY     FINE &  MEDIUM  TUBULAR PORES    ;
                    MODERATELY EFFERVESCENT (HCL)   CONTINUOUS   ; MODERATELY ALKALINE PH- 8.2
                    (THYMOL BLUE)    ; CLEAR   SMOOTH  BOUNDARY   .

 C   1CA             13 - 107 CM.  (  5 -  42 IN.)
                    GRAYISH BROWN   (2.5Y  5/2) EXTERIOR     ; LOAM     ; GRAYISH BROWN   (2.5Y  5/2)
                    CRUSHED  ;  DARK GRAYISH BROWN  (2.5Y  4/2) EXTERIOR    MOIST    ;
                    DARK GRAYISH BROWN  (2.5Y  4/2) CRUSHED MOIST    ; MASSIVE DRY  ; SLIGHTLY HARD    ,
                    FRIABLE  ,  SLIGHTLY STICKY  ,  SLIGHTLY PLASTIC    ; COMMON  FINE    ROOTS
                    THROUGHOUT HORIZON   ; COMMON  FINE    TUBULAR PORES    ; COMMON  SOFT    MEDIUM
                    MASSES OF LIME   ; VIOLENTLY EFFERVESCENT  (HCL)   CONTINUOUS   ;
                    MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE)    ; CLEAR   SMOOTH  BOUNDARY   .

 C   2              107 - 152 CM.  ( 42 -  60 IN.)
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GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; LOAM ; GRAYISH BROWN (2.5Y 5/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE DRY ; SLIGHTLY HARD , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; FEW FINE ROOTS THROUGHOUT HORIZON ; FEW FINE TUBULAR PORES ; FEW SOFT THREAD-LIKE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) .

REMARKS: SPRING WHEAT(EXTREMELY POOR STAND), WEEDS, FOXTAIL & LOCHIN, AREA HAS BEEN LAND-LEVELED, <1% COARSE FRAGMENT 1/2 - 3'' THROUGHOUT, SAND CONTENT OF C_2 GREATER THAN AP OR C_1CA PART OF POPLAR RIVER STUDY HAVE SOIL ANALYSIS DATA

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SOIL SERIES:                                FARNUF         Sample #                          16:45 MAR
SURVEY SAMPLE NO.:                          S78MT     37103
LOCATION:           DANIELS CO. T36N, R48E 2500' W & 600'S NE CORNER SECTION 27 PHOTO NO 658-B
CLASSIFICATION:     TYPIC     ARGIBOROLLS,     FINE-LOAMY    ,  MIXED

SITE NO.: 78103     COUNTY: [redacted]          ELEVATION: 0724 METERS        MONTH SAMPLED: AUGUST
SLOPE:        01%   CLASS:   NEARLY LEVEL       KIND:                         ASPECT:  WEST
AIR TEMPERATURE     ANNUAL:     DEGREES F       SUMMER:     DEGREES F         WINTER:     DEGREES F
SOIL TEMPERATURE    ANNUAL:     DEGREES F       SUMMER:     DEGREES F         WINTER:     DEGREES F
WATER TABLE:        DEPTH:      CM.             MONTH:                        KIND:   NO WATER TABLE
PRECIPITATION:         CM.                      CONTROL SECTION LIMITS --     UPPER: 015 CM  LOWER: 025 CM
PERMEABILITY:       MODERATELY SLOW             DRAINAGE CLASS:  WELL DRAINED
PHYSIOGRAPHY:       FLOODPLAINS                                               STONINESS: CLASS 0
VEGETATION:         CROPS - IRRIGATED
PARENT MATERIAL:    HIGHLY  WEATHERED   ALLUVIUM
                    MIXED LITHOLOGY

  HORIZON                                     PROFILE DESCRIPTION

 A    P              0 -  15 CM.  (  0 -   6 IN.)
                    DARK GRAYISH BROWN  (10YR  4/2) EXTERIOR     ;  HEAVY LOAM   ;  DARK GRAYISH BROWN
                    (10YR  4/2) CRUSHED  ;  V DK GRAYISH BROWN  (10YR  3/2) EXTERIOR    MOIST    ;
(moist color       )STRONG  FINE &  MEDIUM  GRANULAR    DRY STRUCTURE    ,  SLIGHTLY HARD     ,  FRIABLE  ,
(crushed missing   )STICKY   ,  SLIGHTLY PLASTIC     ;  MANY    FINE &  MEDIUM  ROOTS
                    THROUGHOUT HORIZON   ;  COMMON  FINE    TUBULAR PORES     ,  FEW MEDIUM  TUBULAR
                    PORES    ;    4  PERCENT MIXED LITHOLOGY FRAGMENTS    >2 MM      ,   3  PERCENT
                    MIXED LITHOLOGY FRAGMENTS    >2 CM     ;  MILDLY EFFERVESCENT (HCL)   CONTINUOUS   ;
                    MODERATELY ALKALINE PH- 8.0 (THYMOL BLUE)     ;  ABRUPT  SMOOTH  BOUNDARY    .
 B   2T               15 -  25 CM.  (  6 -  10 IN.)
                    V DK GRAYISH BROWN  (10YR  3/2) EXTERIOR      ;  CLAY LOAM    ;  DARK GRAYISH BROWN
(moist color       )(10YR  4/2) CRUSHED  ;  VERY DARK BROWN (10YR  2/2) EXTERIOR    MOIST    ,  STRONG
(crush  missing    )FINE &  MEDIUM  SUBANGULAR BLOCKY   DRY STRUCTURE     ;  SLIGHTLY HARD    ,  FRIABLE  ,
                    STICKY   ,  PLASTIC  ;  COMMON  FINE &  MEDIUM  ROOTS   THROUGHOUT HORIZON    ;
                    COMMON  FINE    TUBULAR PORES    ;  COMMON  DISTINCT    CLAY SKINS
                    IN ROOT CHANNELS AND/OR PORES    ,  COMMON  DISTINCT    CLAY SKINS  ON PED FACES    ;
                     5  PERCENT MIXED LITHOLOGY FRAGMENTS    >2 MM     ,   3  PERCENT MIXED LITHOLOGY
                    FRAGMENTS   >2 CM     ;  MODERATELY EFFERVESCENT (HCL)   CONTINUOUS   ;
                    MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE)     ;  CLEAR   SMOOTH  BOUNDARY   .
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B 3

25 - 43 CM. (10 - 17 IN.)
GRAYISH BROWN , (10YR 5/2) EXTERIOR ; CLAY LOAM ; LIGHT BROWNISH GRAY
(10YR 6/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ;
WEAK MEDIUM & COARSE SUBANGULAR BLOCKY DRY STRUCTURE ; SLIGHTLY HARD ,
FRIABLE , STICKY , PLASTIC ; COMMON FINE & MEDIUM ROOTS
THROUGHOUT HORIZON ; FEW TUBULAR PORES ; 8 PERCENT MIXED LITHOLOGY
FRAGMENTS >2 MM ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ;
MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; CLEAR SMOOTH BOUNDARY .

moist color
crushed missing

C 1

43 - 75 CM. (17 - 30 IN.)
GRAYISH BROWN (10YR 5/2) EXTERIOR ; CLAY LOAM ; GRAYISH BROWN (10YR 5/2)
CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; MASSIVE DRY ; COMMON FINE
ROOTS THROUGHOUT HORIZON ; 8 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM ;
MODERATELY EFFFRVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4.

(moist color
crushed missing
& consistency)

REMARKS: SUB-IRRIGATED ALFALFA & GRASS BY MJH,DRS MICRORELIEF IS INTERMITTENT DRAINAGE CHANNELS, PART OF POPLAR RIVER STUDY HAVE SOIL ANALYSIS DATA

MODERATELY ALKALINE PH- 8.0 (PHENOL RED) ; CLEAR SMOOTH BOUNDARY .

B 3CA

31 - 76 CM. (12 - 30 IN.)
GRAYISH BROWN (10YR 5/2) EXTERIOR ; LOAM ; GRAYISH BROWN (10YR 5/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; WEAK MEDIUM SUBANGULAR BLOCKY DRY STRUCTURE ; HARD , FIRM , SLIGHTLY STICKY , NONPLASTIC ; COMMON FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; FEW FAINT CLAY SKINS ON PED FACES ; 3 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 2 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; FEW SOFT FINE MASSES OF LIME ; MILDLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; CLEAR SMOOTH BOUNDARY .

C 1CA

76 - 102 CM. (30 - 40 IN.)
LIGHT BROWNISH GRAY (10YR 6/2) EXTERIOR ; CLAY LOAM ; LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED ; GRAYISH BROWN (10YR 5/2) EXTERIOR MOIST ; GRAYISH BROWN (10YR 5/2) CRUSHED MOIST ; MASSIVE ; HARD , FIRM , VERY STICKY , PLASTIC ; FEW ROOTS ; MANY FINE TUBULAR PORES ; 7 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 2 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; MANY SOFT FINE & MEDIUM MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; GRADUAL SMOOTH BOUNDARY .

C 2CA

102 - 152 CM. (40 - 60 IN.)
LIGHT BROWNISH GRAY (10YR 6/2) EXTERIOR ; HEAVY CLAY LOAM ; LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED ; GRAYISH BROWN (10YR 5/2) EXTERIOR MOIST ; GRAYISH BROWN (10YR 5/2) CRUSHED MOIST ; MASSIVE ; HARD , FIRM , STICKY , PLASTIC ; FEW ROOTS ; MANY FINE TUBULAR PORES ; 10 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 5 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; COMMON SOFT FINE & MEDIUM MASSES OF LIME , COMMON SOFT THREAD-LIKE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) .

REMARKS: FROM SOIL DRYNESS IT APPEARS IT WAS IRRIGATED JUST ONCE EARLY IN THE SUMMER. PLANTED TO ALFALFA. BY DRS, MJH

SOIL SERIES: WILLIAMS [redacted] sample # 11:55 MA

SURVEY SAMPLE NO.: S78MT 37104
LOCATION: 300' E & 600' N SW CORNER SECTION 33, T33N, R47E
CLASSIFICATION: TYPIC ARGIBOROLLS; FINE-LOAMY , MIXED

SITE NO.: 78104 COUNTY: [redacted] ELEVATION: 0710 METERS MONTH SAMPLED: AUGUST
SLOPE: 01% CLASS: NEARLY LEVEL KIND: PLANE ASPECT:
AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
PRECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 015 CM LOWER: 031 C
PERMEABILITY: SLOW DRAINAGE CLASS: WELL DRAINED
PHYSIOGRAPHY: LEVEL OR UNDULATING UPLANDS STONINESS: CLASS 0
MICRORELIEF: ON SLOPE
VEGETATION: CROPS - IRRIGATED
PARENT MATERIAL: HIGHLY WEATHERED GLACIAL [redacted] Till
CALCAREOUS

HORIZON PROFILE DESCRIPTION

A P 0 - 15 CM. (0 - 6 IN.)
DARK GRAYISH BROWN (10YR 4/2) EXTERIOR ; LOAM ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED ; V DK GRAYISH BROWN (10YR 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (10YR 3/2) CRUSHED MOIST ; MODERATE FINE GRANULAR DRY STRUCTURE PARTING TO MODERATE MEDIUM SUBANGULAR BLOCKY DRY ; SOFT , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; MANY FINE ROOTS THROUGHOUT HORIZON ; FEW FINE TUBULAR PORES ; NONCALCAREOUS (HCL) ; MILDLY ALKALINE PH- 7.8 (PHENOL RED) ; ABRUPT SMOOTH BOUNDARY .

B 2T 15 - 31 CM. (6 - 12 IN.)
DARK GRAYISH BROWN (10YR 4/2) EXTERIOR ; SANDY CLAY LOAM ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED ; V DK GRAYISH BROWN (10YR 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (10YR 3/2) CRUSHED MOIST ; WEAK MEDIUM & COARSE PRISMATIC DRY STRUCTURE PARTING TO MODERATE MEDIUM ANGULAR BLOCKY DRY ; VERY HARD , VERY FIRM , STICKY , SLIGHTLY PLASTIC ; COMMON FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; COMMON FAINT VERY DARK BROWN (10YR 2/2) CLAY SKINS ON PED FACES ; 3 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 2 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; NONCALCAREOUS (HCL) ;

SOIL SERIES: CHERRY *Sample #* 15108 MA

SURVEY SAMPLE NO.: S78MT 3 [illegible]102

LOCATION: DANIELS CO. T36N, R48E, 1150' S & 1200' W OF NE CORNER SECTION 11 PHOTO 659-B

CLASSIFICATION: TYPIC USTOCHREPTS; FINE-SILTY , MIXED , FRIGID

SITE NO.: 78102 COUNTY: ~~[illegible]~~ ELEVATION: 0735 METERS MONTH SAMPLED: AUGUST

SLOPE: 02% CLASS: GENTLY SLOPING KIND: ASPECT: SOUTH

AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE

PRECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102 C

PERMEABILITY: MODERATELY SLOW DRAINAGE CLASS: WELL DRAINED

PHYSIOGRAPHY: STONINESS: CLASS 0

VEGETATION: CROPS - DRYLAND

PARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
SILTSTONE

HORIZON PROFILE DESCRIPTION

A P 0 - 13 CM. (0 - 5 IN.)
DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR ; SILT LOAM ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (2.5Y 3/2) CRUSHED MOIST ; WEAK MEDIUM SUBANGULAR BLOCKY DRY STRUCTURE PARTING TO MODERATE MEDIUM GRANULAR ; SOFT , VERY FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; MANY FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

B 2 13 - 23 CM. (5 - 9 IN.)
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; SILT LOAM ; GRAYISH BROWN (2.5Y 5/2) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (2.5Y 3/2) CRUSHED MOIST ; MODERATE FINE & MEDIUM SUBANGULAR BLOCKY DRY STRUCTURE ; SLIGHTLY HARD , FRIABLE , NONSTICKY , SLIGHTLY PLASTIC ; MANY FINE & MEDIUM ROOTS THROUGHOUT HORIZON ; COMMON FINE & MEDIUM TUBULAR PORES ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 ; CLEAR SMOOTH BOUNDARY .

C 1 23 - 152 CM. (9 - 60 IN.)

GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; SILT LOAM ; GRAYISH BROWN (2.5Y 5/2)
CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE DRY ; SLIGHTLY HARD ,
FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON FINE ROOTS
THROUGHOUT HORIZON ; COMMON FINE & MEDIUM TUBULAR PORES ; 5 PERCENT
MIXED LITHOLOGY FRAGMENTS >2 MM ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ;
STRONGLY ALKALINE PH- 8.6 (THYMOL BLUE) .

REMARKS: DRYLAND ALFALFA, IRRIGATED DURING PERIOD OF 1956-1965 BY MJH & DRS

PLE NO.1

[illegible]N: DANIELS CO. T34 [illegible] 525 [illegible] SECTION 21(150'E&150'N [illegible]

CLASSIFICATION: TYPIC USTIFLUVENTS; FINE-LOAMY , MIXED (CALCAREOUS) , FRIGID

SITE NO.: [redacted]105 COUNTY: [redacted] ELEVATION: 0700 METERS MONTH SAMPLED: AUGUST

SLOPE: 01% CLASS: NEARLY LEVEL KIND: ASPECT: EAST

AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE

PRECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102

PERMEABILITY: MODERATE DRAINAGE CLASS: WELL DRAINED

PHYSIOGRAPHY: FLOODPLAINS STONINESS: CLASS 0

VEGETATION: CROPS - IRRIGATED

PARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM

MIXED LITHOLOGY

(Havrelon)

HORIZON PROFILE DESCRIPTION

A P 0 - 15 CM. (0 - 6 IN.)
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; SILT LOAM ; GRAYISH BROWN (2.5Y 5/2)
CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MODERATE MEDIUM GRANULAR
DRY STRUCTURE PARTING TO WEAK MEDIUM SUBANGULAR BLOCKY DRY ; HARD ,
FRIABLE , SLIGHTLY STICKY , PLASTIC ; MANY FINE ROOTS
THROUGHOUT HORIZON ; MANY MEDIUM TUBULAR PORES ; FEW SOFT THREAD-LIKE
MASSES OF LIME ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ;
MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

C 1CA 15 - 76 CM. (6 - 30 IN.)
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; SILT LOAM ; GRAYISH BROWN (2.5Y 5/2)
CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE DRY ; SLIGHTLY HARD ,
FRIABLE , SLIGHTLY STICKY , PLASTIC ; COMMON FINE ROOTS
THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES , FEW MEDIUM TUBULAR
PORES ; FEW SOFT FINE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL)
CONTINUOUS ; STRONGLY ALKALINE PH- 8.6 (THYMOL BLUE) ; GRADUAL SMOOTH
BOUNDARY .

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C   2CA            76 - 152 CM.  ( 30 -  60 IN.)
                   GRAYISH BROWN   (2.5Y  5/2) EXTERIOR     ; LIGHT SILTY CLAY LOAM    ;
                   GRAYISH BROWN   (2.5Y  5/2) CRUSHED  ;  DARK GRAYISH BROWN  (2.5Y  4/2) EXTERIOR
                   MOIST    ;  DARK GRAYISH BROWN  (2.5Y  4/2) CRUSHED MOIST     ;  MASSIVE DRY  ;
                   SLIGHTLY HARD    ,  FRIABLE  ,  STICKY   ,  PLASTIC  ;  FEW ROOTS    ;  FEW SOFT
                   FINE   MASSES OF LIME    ;  VIOLENTLY EFFERVESCENT  (HCL)   CONTINUOUS    ;
                   STRONGLY ALKALINE   PH= 8.6 (THYMOL BLUE)  .

   REMARKS:        IRRIGATION DILF) IRRIGATED SPRING WHEAT, UNDERSTORY OF ALFALFA, BY MJH & DRS, SA
                   MPLE NOT MODEL, LOCATION OF SITE AT MOUTH OF LARGE DRAINAGE THAT HAS SILTSTONE T
                   HIS SOIL WOULD PROBABLY MAKE A FINE-SILTY USTIFLUVENT THE 15-76 CM ZONE HAS LOTS
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SOIL SERIES: FARLAND Sample # 11:55 MAR

URVEY SAMPLE NO.: S78MT 37106
OCATION: 1875' E & 2070' S OF NW CORNER SECTION 26, T34N, R48E
LASSIFICATION: TYPIC ARGIBOROLLS; FINE-SILTY , MIXED

ITE NO.: 78106 COUNTY: [redacted] ELEVATION: (694 METERS MONTH SAMPLED: AUGUST
LOPE: 01% CLASS: NEARLY LEVEL KIND: [redacted] ASPECT:
IR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
OIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
ATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
RECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 013 CM LOWER: 030 CM
ERMEABILITY: MODERATELY SLOW DRAINAGE CLASS: WELL DRAINED
HYSIOGRAPHY: ALLUVIAL OR COLLUVIAL FANS STONINESS: CLASS 0
ICRORELIEF: [redacted]
EGETATION: CROPS - IRRIGATED
ARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
CALCAREOUS CONGLOMERATE

HORIZON PROFILE DESCRIPTION

A P 0 - 13 CM. (0 - 5 IN.)
DARK GRAYISH BROWN (10YR 4/2) EXTERIOR ; SILT LOAM ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED ; V DK GRAYISH BROWN (10YR 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (10YR 3/2) CRUSHED MOIST ; MODERATE FINE & MEDIUM GRANULAR MOIST STRUCTURE PARTING TO MODERATE MEDIUM SUBANGULAR BLOCKY MOIST ; HARD , FRIABLE , STICKY , SLIGHTLY PLASTIC ; MANY FINE ROOTS THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; 1 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM ; NONCALCAREOUS (HCL) ; MODERATELY ALKALINE PH= 8.0 (PHENOL RED) ; ABRUPT SMOOTH BOUNDARY .

B 2T 13 - 30 CM. (5 - 12 IN.)
V DK GRAYISH BROWN (10YR 3/2) EXTERIOR ; SILTY CLAY LOAM ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED ; VERY DARK BROWN (10YR 2/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (10YR 3/2) CRUSHED MOIST ; WEAK COARSE PRISMATIC MOIST STRUCTURE PARTING TO MODERATE MEDIUM SUBANGULAR BLOCKY MOIST ; HARD , FRIABLE , STICKY , PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; COMMON DISTINCT CLAY SKINS IN ROOT CHANNELS AND/OR PORES , COMMON DISTINCT CLAY SKINS ON PED FACES ; 1 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM ;

NONCALCAREOUS (HCL) ; MODERATELY ALKALINE PH- 8.0 (PHENOL RED) ; CLEAR SMOOTH BOUNDARY .

B 3CA 30 - 61 CM. (12 - 24 IN.)
DARK GRAYISH BROWN (10YR 4/2) EXTERIOR ; SILTY CLAY LOAM ; GRAYISH BROWN (10YR 5/2) CRUSHED ; V DK GRAYISH BROWN (10YR 3/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; WEAK MEDIUM SUBANGULAR BLOCKY MOIST STRUCTURE ; SOFT , FIRM , STICKY , PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; FEW FAINT CLAY SKINS ON PED FACES ; 1 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM ; FEW SOFT FINE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) ; GRADUAL SMOOTH BOUNDARY .

C 1 61 - 152 CM. (24 - 60 IN.)
GRAYISH BROWN (10YR 5/2) EXTERIOR ; HEAVY SILTY CLAY LOAM ; LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE ; SLIGHTLY HARD , FIRM , STICKY , PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; COMMON SOFT FINE MASSES OF LIME ; ~~[illegible]~~ violently effervescent (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) .

REMARKS: CROP-OATS, IRRIGATED, AREA LAND LEVELED FOR FLOOD IRRIGATION BY DRS, MJH

L SERIES: FARLAND Sample # 15:08 MAR 23

VEY SAMPLE NO.: S78MT 37107
ATION: 1300' E & 300' S OF THE NW CORNER SECTION 26, T36N, [redacted] R43E
SSIFICATION: TYPIC ARGIBOROLLS; FINE-SILTY , MIXED

E NO.: 26107 COUNTY: [redacted] ELEVATION: 0829 METERS MONTH SAMPLED: AUGUST
PE: 01% CLASS: NEARLY LEVEL KIND: PLANE ASPECT: SOUTHWEST
TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
I TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
ER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
CIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 018 CM LOWER: 028 CM
MEABILITY: MODERATELY SLOW DRAINAGE CLASS: WELL DRAINED
SIOGRAPHY: ALLUVIAL OR COLLUVIAL FANS STONINESS: CLASS 0
RORELIEF: [redacted]
ETATION: CROPS - IRRIGATED
ENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
[redacted]

HORIZON PROFILE DESCRIPTION

A P 0 - 18 CM. (0 - 7 IN.)
DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR ; HEAVY SILT LOAM ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2)
EXTERIOR MOIST ; V DK GRAYISH BROWN (2.5Y 3/2) MOIST ; STRONG
FINE & MEDIUM GRANULAR DRY STRUCTURE PARTING TO MODERATE MEDIUM
SUBANGULAR BLOCKY DRY ; SOFT , VERY FRIABLE , STICKY ,
SLIGHTLY PLASTIC ; MANY FINE ROOTS THROUGHOUT HORIZON ; MANY
FINE TUBULAR PORES ; NONCALCAREOUS (HCL) ; MILDLY ALKALINE PH- 7.8
(PHENOL RED) ; ABRUPT SMOOTH BOUNDARY .

B 2T 18 - 28 CM. (7 - 11 IN.)
DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR ; SILTY CLAY LOAM ; GRAYISH BROWN
(2.5Y 5/2) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; WEAK MEDIUM PRISMATIC DRY
STRUCTURE PARTING TO MODERATE MEDIUM SUBANGULAR BLOCKY DRY ;
SLIGHTLY HARD , FRIABLE , STICKY , PLASTIC ; MANY FINE ROOTS
THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; COMMON DISTINCT
CLAY SKINS IN ROOT CHANNELS AND/OR PORES , COMMON DISTINCT CLAY SKINS
ON PED FACES ; NONCALCAREOUS (HCL) ; MILDLY ALKALINE PH- 7.8

(PHENOL RED) ; CLEAR SMOOTH BOUNDARY .

B 3 28 - 46 CM. (11 - 18 IN.) .
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; LIGHT SILT LOAM ; GRAYISH BROWN (2.5Y 5/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MODERATE MEDIUM SUBANGULAR BLOCKY DRY STRUCTURE PARTING TO WEAK FINE ANGULAR BLOCKY DRY ; SOFT , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON ROOTS ; COMMON FINE TUBULAR PORES , FEW MEDIUM TUBULAR PORES ; COMMON FAINT CLAY SKINS ON PED FACES ; MILDLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.0 (PHENOL RED) ; CLEAR SMOOTH BOUNDARY .

C 1CA 46 - 71 CM. (18 - 28 IN.)
(3 colors missing) LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SILT LOAM ; MASSIVE DRY ; SOFT , VERY FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; FEW PORES ; COMMON SOFT FINE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) ; GRADUAL SMOOTH BOUNDARY .

C 2 71 - 152 CM. (28 - 60 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SILT LOAM ; LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; GRAYISH BROWN (2.5Y 5/2) EXTERIOR MOIST ; GRAYISH BROWN (2.5Y 5/2) CRUSHED MOIST ; MASSIVE DRY ; SOFT , VERY FRIABLE sticky, SLIGHTLY PLASTIC ; FEW ROOTS ; FEW PORES ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.2 (THYMOL BLUE) .

REMARKS: CROP-ALFALFA, IRRIGATED & LAND LEVELED. B3 HORIZON IS HIGH IN VFS, TEXTURE NEAR A VFSL MINIMAL COLOR CHANGE UPON DRYING IN C2 HORIZON BY MJH

SMOOTH BOUNDARY .

B 3

28 - 53 CM. (11 - 21 IN.) GRAYISH BROWN (10YR 5/2) EXTERIOR ; SANDY CLAY LOAM ; GRAYISH BROWN (10YR 5/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; WEAK MEDIUM PRISMATIC DRY STRUCTURE PARTING TO MODERATE FINE & MEDIUM SUBANGULAR BLOCKY DRY ; HARD , FIRM , STICKY , SLIGHTLY PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; FEW FAINT CLAY SKINS ON PED FACES ; 3 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM ; MILDLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.0 (PHENOL RED) ; CLEAR SMOOTH BOUNDARY .

C 1CA

53 - 86 CM. (21 - 34 IN.) LT. YELLOWISH BROWN (2.5Y 6/4) EXTERIOR ; FINE SANDY LOAM AND SANDY LOAM ; LT. YELLOWISH BROWN (2.5Y 6/4) CRUSHED ; GRAYISH BROWN (10YR 5/2) EXTERIOR MOIST ; GRAYISH BROWN (10YR 5/2) CRUSHED MOIST ; SINGLE GRAIN DRY ; LOOSE , LOOSE , NONSTICKY , NONPLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; 12 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 2 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; COMMON SOFT MEDIUM MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) ; CLEAR SMOOTH BOUNDARY .

C 2

86 - 152 CM. (34 - 60 IN.) LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; GRAVELLY FINE SANDY LOAM AND GRAVELLY SANDY LOAM ; LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; GRAYISH BROWN (10YR 5/2) EXTERIOR MOIST ; GRAYISH BROWN (10YR 5/2) CRUSHED MOIST ; SINGLE GRAIN DRY ; LOOSE , LOOSE , NONSTICKY , NONPLASTIC ; FEW ROOTS ; 21 PERCENT MIXED LITHOLOGY FRAGMENTS >2 MM , 3 PERCENT MIXED LITHOLOGY FRAGMENTS >2 CM ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) .

REMARKS:

LIME CONCRETIONS ON THE BOTTOM SIDE OF COARSE FRAGMENTS IN C HORIZONS. TEXTURE BORDERS BETWEEN FSL & LS MATRIX. BY MJH SPRING WHEAT UNDER CENTER PIVOT IRRIGATION SYSTEM

C 2CA 107 - 152 CM. (42 - 60 IN.)
LT. YELLOWISH BROWN (2.5Y 6/4) EXTERIOR ; LIGHT CLAY ; LT. YELLOWISH BROWN (2.5Y 6/4) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2) EXTERIOR MOIST ; V DK GRAYISH BROWN (2.5Y 3/2) CRUSHED MOIST ; MASSIVE MOIST ; FEW ROOTS ; COMMON MEDIUM TUBULAR PORES ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; STRONGLY ALKALINE PH= 8.6 (THYMOL BLUE) .

no const.

REMARKS: 7 PHOTO NO 657-A IRRIGATED MIXED HAY AGSM, CRESTED WHEATGRASS, ALFALFA, ARFR4,AREA WAS LAND LEVELED PART OF POPLAR RIVER STUDY HAVE SOIL ANALYSIS DATA, LOCATION 1300'N & 200 W OF SE CORNER OF SECTION 7 BY MJH & DRS

SOIL SERIES: HAVRELON Sample # 11:55 MAR

SURVEY SAMPLE NO.: S78MT 37118
LOCATION: DANIELS CO. T36N, R48E 2400' E & 600' S OF NW CORNER OF SECTION 32
CLASSIFICATION: TYPIC USTIFLUVENTS: FINE-LOAMY , MIXED (CALCAREOUS) , FRIGID

SITE NO.: 78118 COUNTY: [redacted] ELEVATION: 0720 METERS MONTH SAMPLED: AUGUST
SLOPE: 01% CLASS: NEARLY LEVEL KIND: ASPECT:
AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F
WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE
PRECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102 CM
PERMEABILITY: MODERATELY SLOW DRAINAGE CLASS: WELL DRAINED
PHYSIOGRAPHY: FLOODPLAINS STONINESS: CLASS 0
VEGETATION: CROPS - DRYLAND
PARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM
CALCAREOUS

HORIZON PROFILE DESCRIPTION

A P 0 - 10 CM. (0 - 4 IN.)
GRAYISH BROWN (2.5Y 5/2) EXTERIOR ; HEAVY LOAM ; DARK GRAYISH BROWN
(2.5Y 4/2) CRUSHED ; V DK GRAYISH BROWN (2.5Y 3/2) EXTERIOR MOIST ;
V DK GRAYISH BROWN (2.5Y 3/2) CRUSHED MOIST ; MODERATE FINE & MEDIUM
GRANULAR DRY STRUCTURE ; ~~LOOSE~~ soft , FRIABLE , STICKY ,
SLIGHTLY PLASTIC ; MANY FINE ROOTS THROUGHOUT HORIZON ; FEW FINE
TUBULAR PORES ; MODERATELY EFFERVESCENT (HCL) CONTINUOUS ;
MODERATELY ALKALINE PH- 8.0 (THYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

A 1 10 - 18 CM. (4 - 7 IN.)
DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR ; SILTY CLAY LOAM ; GRAYISH BROWN
(2.5Y 5/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ;
DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MODERATE MEDIUM
SUBANGULAR BLOCKY DRY STRUCTURE PARTING TO MODERATE MEDIUM ANGULAR BLOCKY
DRY ; MANY FINE ROOTS THROUGHOUT HORIZON ; MANY FINE & MEDIUM
(no. Const.) TUBULAR CONTINUOUS PORES ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ;
MODERATELY ALKALINE PH- 8.0 (THYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

C 1CA 18 - 76 CM. (7 - 30 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; LOAM ; LIGHT BROWNISH GRAY

```
(no const.)   (2.5Y  6/2) CRUSHED  ;  DARK GRAYISH BROWN  (2.5Y  4/2) EXTERIOR    MOIST    ;
              DARK GRAYISH BROWN  (2.5Y  4/2) CRUSHED MOIST    ;  MASSIVE MOIST    ;  COMMON
              FINE    ROOTS   THROUGHOUT HORIZON   ;  COMMON  FINE    TUBULAR PORES    ;
              VIOLENTLY EFFERVESCENT  (HCL) ;  CONTINUOUS   ;  STRONGLY ALKALINE   PH= 8.6
              (THYMOL BLUE)    ;  GRADUAL SMOOTH  BOUNDARY   .

C   2CA       76 - 152 CM.  ( 30 -  60 IN.)
              LIGHT BROWNISH GRAY (2.5Y  6/2) EXTERIOR     ;  SANDY LOAM   ;  LT. YELLOWISH BROWN
              (2.5Y  6/4) CRUSHED  ;  DARK GRAYISH BROWN  (2.5Y  4/2) EXTERIOR    MOIST    ;
(no const.)   DARK GRAYISH BROWN  (2.5Y  4/2) CRUSHED MOIST    ;  MASSIVE MOIST    ;  FEW ROOTS   ;
               8  PERCENT MIXED LITHOLOGY FRAGMENTS   >2 MM    ;   1  PERCENT MIXED LITHOLOGY
              FRAGMENTS   >2 CM    ;  VIOLENTLY EFFERVESCENT  (HCL)   CONTINUOUS   ;
              MODERATELY ALKALINE PH= 8.4 (THYMOL BLUE)  .

REMARKS:      ALFALFA, BARLEY, SWEET CLOVER, SLENDER WHEATGRASS, DANDILION BY DRS & MJH PART O
              F POPLAR RIVER STUDY HAVE SOIL ANALYSIS DATA
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SOIL SERIES: LOHLER 15:08 MAR

Sample #

SURVEY SAMPLE NO.: S78MT 37119

LOCATION: 1250' E & 600' N OF SW CORNER OF SECTION 33, T36N, R48E

CLASSIFICATION: TYPIC USTIFLUVENTS: FINE , MONTMORILLONITIC (CALCAREOUS) , FRIGID

SITE NO.: 78119 COUNTY: [redacted] ELEVATION: 0720 METERS MONTH SAMPLED: SEPTEMBER

SLOPE: 01% CLASS: NEARLY LEVEL KIND: PLANE ASPECT:

AIR TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

SOIL TEMPERATURE ANNUAL: DEGREES F SUMMER: DEGREES F WINTER: DEGREES F

WATER TABLE: DEPTH: CM. MONTH: KIND: NO WATER TABLE

PRECIPITATION: CM. CONTROL SECTION LIMITS -- UPPER: 025 CM LOWER: 102 CM

PERMEABILITY: SLOW DRAINAGE CLASS: WELL DRAINED

PHYSIOGRAPHY: FLOODPLAINS STONINESS: CLASS 0

VEGETATION: CROPS - DRYLAND

PARENT MATERIAL: HIGHLY WEATHERED ALLUVIUM

CALCAREOUS

HORIZON PROFILE DESCRIPTION

A P

0 - 18 CM. (0 - 7 IN.)
LIGHT BROWNISH GRAY (10YR 6/2) EXTERIOR ; HEAVY SILTY CLAY LOAM ; LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED ; DARK GRAYISH BROWN (10YR 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST ; MODERATE FINE & MEDIUM GRANULAR MOIST STRUCTURE PARTING TO WEAK MEDIUM SUBANGULAR BLOCKY MOIST ; HARD , FIRM , STICKY , PLASTIC ; FEW MEDIUM ROOTS THROUGHOUT HORIZON ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE PH- 8.4 (THYMOL BLUE) ; ABRUPT SMOOTH BOUNDARY .

C 1SA

18 - 36 CM. (7 - 14 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SILTY CLAY LOAM ; LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE MOIST ; HARD , FIRM , STICKY , PLASTIC ; COMMON FINE ROOTS THROUGHOUT HORIZON ; MANY FINE TUBULAR PORES ; COMMON SOFT FINE SALT CRYSTALS , COMMON SOFT FINE MASSES OF LIME ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; VERY STRONGLY ALKALINE PH- 9.4 (THYMOL BLUE) ; CLEAR SMOOTH BOUNDARY .

C 2CA 36 - 122 CM. (14 - 48 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SILTY CLAY LOAM ;
LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2)
EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE
MOIST ; HARD , FIRM , STICKY , PLASTIC ; FEW FINE ROOTS
THROUGHOUT HORIZON ; COMMON FINE TUBULAR PORES ; VIOLENTLY EFFERVESCENT
(HCL) CONTINUOUS ; MODERATELY ALKALINE PH. 8.4 (THYMOL BLUE) ; CLEAR
SMOOTH BOUNDARY .

C 3CA 122 - 152 CM. (48 - 60 IN.)
LIGHT BROWNISH GRAY (2.5Y 6/2) EXTERIOR ; SANDY CLAY LOAM ;
LIGHT BROWNISH GRAY (2.5Y 6/2) CRUSHED ; DARK GRAYISH BROWN (2.5Y 4/2)
EXTERIOR MOIST ; DARK GRAYISH BROWN (2.5Y 4/2) CRUSHED MOIST ; MASSIVE
MOIST ; SLIGHTLY HARD , FRIABLE , SLIGHTLY STICKY , SLIGHTLY PLASTIC ;
FEW ROOTS ; VIOLENTLY EFFERVESCENT (HCL) CONTINUOUS ; MODERATELY ALKALINE
PH. 8.4 (THYMOL BLUE) .

REMARKS: CLOSE TO FINE LOAMY. BY DRS. MJH. VEGETATION-SPRING WHEAT

APPENDIX 2. SAMPLE LOCATIONS AND FIELD NOTES FOR THE LOWER BASIN

POPLAR RIVER SOIL SAMPLES

Location, Description & Analyses Index

Site: FP-1
Location: West center of NE¼, NE¼ Sec. 16, T. 29 N., R. 51E
Description: Floodplain alluvium; located in former irrigation project

Sample No.	Sample Depth
FP-1a	20 - 24 inches
FP-1b	38 - 42 inches
FP-1c	48 - 52 inches

Site: FP-2
Location: Approximate center of Sec. 29, T. 29 N., R. 51 E
Description: Floodplain alluvium; located in former irrigation project - not certain if previously irrigated

Sample No.	Sample Depth
FP-2a	0 - 4 inches
FP-2b	20 - 24 inches
FP-2c	32 - 36 inches
FP-2d	56 - 60 inches

Site: FP-3
Location: South edge of SW¼, SE¼ Sec. 33, T. 30 N., R. 51 E
Description: Floodplain alluvium, very sandy; sod outside of known irrigation area

Sample No.	Sample Depth
FP-3	12 - 24 inches

Site: FP-4
Location: NE corner of Sec. 14, T. 29 N., R. 53 E
Description: Upland alluvium (glacial outwash); dry land summer fallow

Sample No.	Sample Depth
FP-4a	8 - 16 inches
FP-4b	22 - 28 inches
FP-4c	35 - 41 inches

Site: FP-5
Location: Corner Secs. 8, 9, 16 & 17, T. 29 N., R. 53 E
Description: Upland alluvium (glacial outwash); undistrubed sod

Sample No.	Sample Depth
FP-5a	8 - 12 inches
FP-5b	16 - 22 inches

Site: FP-6
Location: Corner Secs. 34 & 35, T. 29 N., R. 52 E.
Description: Dune sand over glacial outwash (Parshall Series?); preglacial Poplar River Channel

Sample No.	Sample Depth
FP-6a	8 - 12 inches
FP-6b	24 - 30 inches
FP-6c	46 - 52 inches

Site: FP-7
Location: Corner Secs. 23, 24, 25 & 26, T. 28 N., R. 51 E.
Description: Dune sand over glacial till, glacial till at 46 inches; Dooley Series

Sample No.	Sample Depth
FP-7a	32 - 36 inches
FP-7b	52 - 58 inches

Site: FP-8
Location: Corner Secs. 17, 16, 20 & 21, T. 28 N., R. 51 E.
Description: Glacial till parent material; Williams Loam Series

Sample No.	Sample Depth
FP-8a	8 - 12 inches
FP-8b	24 - 28 inches
FP-8c	48 - 52 inches

Site: FP-9
Location: Near center of NW¼ SW¼ Sec. 24, T. 33 N., R. 48 E.
Description: Floodplain alluvium; in irrigation project (Havrelon Series?)

Sample No.	Sample Depth
FP-9a	4 - 8 inches
FP-9b	16 - 20 inches
FP-9c	30 - 36 inches

Site: FP-10
Location: Near centr of NE¼ SW¼ Sec. 24, T. 33 N., R. 48 E.
Description: Well drained colluvial soil; in irrigation project

Sample No.	Sample Depth
FP-10a	4 - 8 inches
FP-10b	16 - 20 inches
FP-10c	30 - 36 inches
FP-10d	54 - 60 inches

Site: FP-11
Location: Near center of NW¼ SE¼ Sec. 24, T. 33 N., R. 48 E.
Description: Well drained colluvial soil; sod adjacent to irrigation project

Sample No.	Sample Depth
FP-11a	4 - 8 inches
FP-11b	16 - 20 inches
FP-11c	30 - 34 inches
FP-11d	54 - 60 inches

APPENDIX 3. ANALYTICAL RESULTS FOR THE LOWER BASIN

Charge # 2589-2620

G&C __ Station __ Other ____

Date Analyses Desired ____

Name Mike Kaczmarek Plot Identity ____

Dept. Morrison-Maierle, Inc.

Address 910 Helena Ave. Sample Disposition: Discard __

City Helena, MT 59601 Return __ Other ____

LAB USE ONLY

Date Received 12/1/77

Date Sent 1/23/78

Remarks:

YOUR SAMPLE IDENTIFICATION	LAB #	pH	Cond. mmhos	POTASSIUM ext. ppm	Calcium ext. meq/100g	Magnesium ext. meq/100 g	Sodium ext. meq/100 g	Texture (hand)
FP-1a 20-24" QAl	2589	8.4	0.8	220	35.2	15.5	0.2	SiCL
FP-1b 38-42" Qal	2590	8.5	0.9	150	32.4	10.5	0.7	SiCL
FP-1c 48-52" Qal	2591	8.4	1.0	130	24.4	6.2	0.5	SL
FP-2a 0- 4" Qal	2592	7.7	1.3	1102	24.0	9.7	0.9	C
FP-2b 20-24" Qal	2593	8.2	2.3	390	38.4	10.9	4.6	C
FP-2c 32-36" Qal	2594	8.3	2.0	240	34.8	8.5	4.7	CL
FP-2d 56-60" Qal	2595	7.8	7.9	530	36.0	12.1	6.8	C
FP-3 12-24" Qal	2596	8.7	0.6	180	27.6	7.7	0.2	CL
FP-4a 8-16" Qow	2597	8.2	0.7	130	39.2	9.0	trace	CL
FP-4b 22-28" Qow	2598	8.9	1.5	120	31.2	14.1	0.5	CL
FP-4c 35-41" Qow	2599	9.0	1.1	180	27.6	11.0	2.6	CL
FP-5a 8-12" Qow	2600	7.6	0.4	330	11.6	5.3	trace	CL
FP-5b 16-22" Qow	2601	8.3	0.6	130	34.4	6.6	0.1	CL
FP-6a 8-12" Qow/Qt	2602	8.7	0.6	120	29.2	10.4	0.4	CL
FP-6b 24-30 Qd/Qow/Qt	2603	9.3	1.3	90	28.0	14.3	2.1	CL
FP-6c 46-52 Qow	2604	8.7	2.5	50	15.2	4.5	1.0	LS
FP-7a 32-36 Qd	2605	7.9	0.4	110	6.8	2.1	trace	SL
FP-7b 52-58 Qt	2606	8.5	0.6	120	33.2	8.2	0.1	SCL
FP-8a 8-12" Qt	2607	8.2	0.6	140	8.8	5.3	0.1	CL
FP-8b 24-28" Qt	2608	8.6	2.8	170	27.2	15.1	1.2	CL

Total Cost Per Column $____ $____ $____ $____ $____ $____

Charge #

G&C __ Station __ Other _____

Name Mi Kaczmarek (cont) Plot Identity

Dept.

Address

City

Sample Disposition: Discard__

Return__ Other

Date Analyses Desired

LAB USE ONLY

Date Received

Date Sent

Remarks:

YOUR SAMPLE IDENTIFICATION	LAB #	XXXXXXXXX meq/ C.E.C. 100g	XXXXXXXXXS Boron *ppm	XXXXXXXXXX meq/ Calcium L	Magnesium meq/L	Sodium meq/L		
	2589	29	3.7	1.8	3.4	1.0		
	2590	19	4.3	1.4	3.4	6.0		
	2591	18	1.3	2.4	3.0	7.5		
	2592	44	2.6	4.1	3.1	4.6		
	2593	48	4.3	3.1	2.1	11.7		
	2594	38	6.1	3.3	1.9	25.9		
	2595	44	3.3	8.3	14.8	33.1		
	2596	22		1.9	3.4	1.9		
	2597	20		2.7	3.1	0.6		
	2598	19		2.0	3.8	4.2		
	2599	21		0.3	1.4	11.8		
	2600	24		4.6	2.2	0.2		
	2601	23		2.9	3.8	0.4		
	2602	20		1.6	2.3	2.8		
	2603	17		.05	1.2	8.3		
	2604	11		7.8	31.4	23.5		
	2605	17		3.6	3.3	0.4		
	2606	24		1.7	1.9	0.7		
	2607	20		2.5	3.4	1.2		
	2608	17		1.8	20.9	14.1		

Total Cost Per Column $ $ $ $ $ $ $

GRAND TOTAL $

Charge #__________

G&C __ Station __ Other _____

Date Analyses Desired__________

LAB USE ONLY

Date Received__________

Date Sent__________

Remarks:

Name Mike Kaczmarek (cont.) Plot Identity__________

Dept.__________

Address__________ Sample Disposition: Discard__

City__________ Return__ Other__________

YOUR SAMPLE IDENTIFICATION	LAB #	NITRATE-N pH	PHOSPHORUS Cond. mmhos	POTASSIUM Ext. ppm	Calcium ext. meq/100g	Magnesium ext. meq./100g	Sodium ext. meq/100g	Texture (hand)
FP-8c 48-52" Qt	2609	8.5	4.3	210	28.4	13.2	1.5	CL
FP-9a 4- 8" Qal	2610	8.2	0.6	150	30.0	4.4	trace	SiCL
FP-9b 16-20" Qal	2611	8.1	0.8	80	27.2	2.9	0.1	L
FP-9c 30-36" Qal	2612	8.4	0.6	70	21.6	1.9	0.1	SL
FP-10a 4-8" Qac	2613	8.1	1.2	390	32.4	6.2	0.6	CL
FP-10b 16-20" Qac	2614	8.0	1.7	260	32.4	9.8	1.8	CL
FP-10c 30-36" QAc	2615	8.1	1.4	190	32.4	8.0	0.2	CL
FP-10d 54-60" Qac	2616	7.9	2.0	180	37.6	7.8	0.4	CL
FP-11a 4- 8" Qac	2617	7.8	0.8	230	32.4	4.8	trace	CL
FP-11b 16-20" Qac	2618	7.9	0.9	260	33.6	12.1	0.1	CL
FP-11c 30-34" Qac	2619	8.0	1.4	310	3418	11.0	0.4	CL
FP-11d 54-60" Qac	2620	8.0	1.1	190	32.0	7.8	0.2	CL

Total Cost Per Column $_____ $_____ $_____ $_____ $_____ $_____ $_____

Charge #

G&C __ Station __ Other ____

Date Analyses Desired

LAB USE ONLY

Name Mike zmarek (cont.) Plot Identity

Dept.

Address

Sample Disposition: Discard__

City

Return__ Other

Date Received

Date Sent

Remarks:

YOUR SAMPLE IDENTIFICATION	LAB #	meq/ C.E.C. 100g	*Boron ppm	meq/ Calcium L	Magnesium Meq./L	Sodium Meq./L		
	2609	16		4.2	40.8	21.1		
	2610	17	not enough soil	4.1	3.3	0.3		
	2611	17	not enough soil	3.8	2.6	1.1		
	2612	11	0.6	3.4	2.0	2.6		
	2613	27	5.3	5.2	3.4	4.5		
	2614	31	4.1	3.1	2.8	8.9		
	2615	21	1.3	3.0	6.2	2.2		
	2616	20	3.1	3.8	6.6	3.3		
	2617	20	0.8	5.1	3.2	0.4		
	2618	30	3.1	2.4	4.1	1.0		
	2619	33	4.1	2.7	4.0	2.1		
	2620	17	3.1	2.3	4.0	2.1		

*The boron values we have reported to you are 'hot water soluble'. This is the guideline method for plant available boron. The results were obtained using method #73b of U.S.D.A. Agricultural Handbook #60. Hot water soluble boron is one of the best indices to plant available boron.

Total Cost Per Column $ $ $ $ $ $ $

GRAND TOTAL $